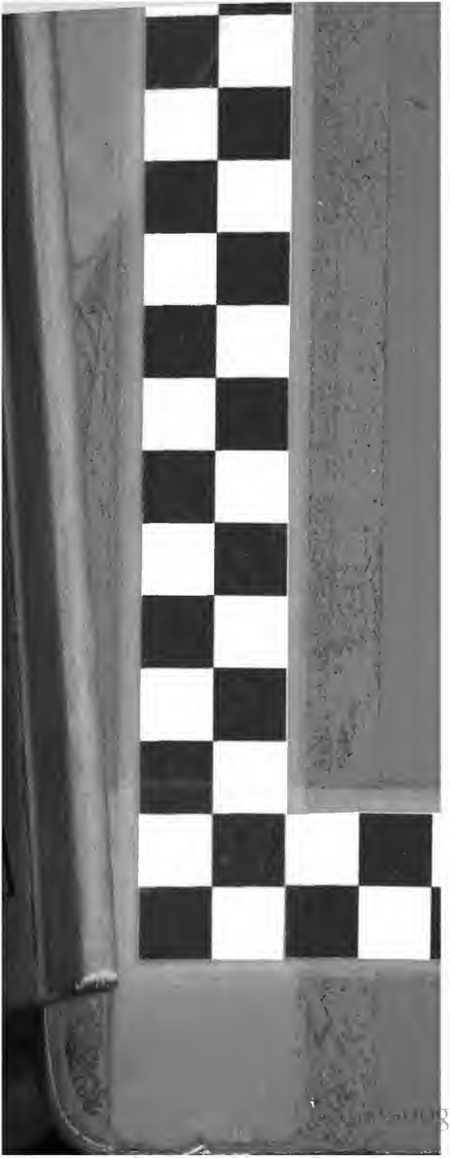

WIRELESS

IN THE

HOME

by

Lee de Forest

Ph. D., Sc. D.

Price 15 *Cents*

WIRELESS

IN THE

HOME

CONTAINING
Explanation of the Theory of Radio; The Value of Radio in the Home; The Essentials of a Radio Receiving Station; How to Erect an Antennae; The Purposes and Uses of Various Pieces of Equipment; The Two-Step Ampl'fier

by

Lee de Forest
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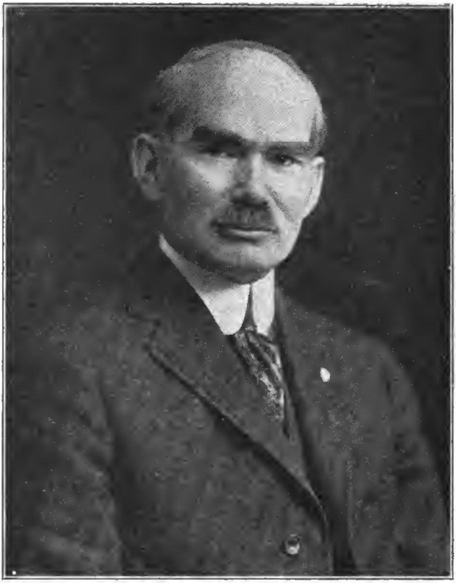


Dr. Lee de Forest

If you haven't a hobby—get one. Ride it. Your interest and zest in life will triple. You will find common ground with others—a joy in getting together, in exchange of ideas—which only hobbyists can know.

Wireless is of all hobbies the most interesting. It offers the widest limits, the keenest fascination, either for intense competition with others, near and far, or for quiet study and pure enjoyment in the still night hours as you welcome friendly visitors from the whole wide world.

Lee de Forest.

The Fascination of Radio Telephony and Telegraphy

NINETEEN years ago when Guglielmo Marconi first succeeded in transmitting wireless signals across the Atlantic Ocean, the Science, which has since become known as Radio Telegraphy, received its initial start toward popularity in this country. From then to now the interest in the subject has grown tremendously and today the sending and receiving of all kinds of messages by wireless is as common as sending and receiving messages through the mails.

The air is literally full of wireless messages at all times. Big and powerful commercial, Government, news-bureau and other stations are constantly transmitting the news of the world by Radio; are reporting the latest events in Europe, South America, far off Japan and Australia, as well as the news of national and local importance in our own country. Ships at sea; slow lumbering freighters, swift trans-atlantic liners, grim powerful battleships; are all sending ashore news of what is happening at sea. Is a vessel in distress? The wireless tells the world. Who does not remember the part played by wireless in the Titanic disaster? What stopped the Carpathian in mid-ocean and sent her racing against time and to save life? Many large boats publish daily newspapers on board while crossing the ocean. Where do they get the news? By wireless from shore.

Land stations are sending messages constantly. Messages that can be picked up by anyone long before they reach the general public through the newspapers. Has a terrific fire destroyed half a distant city? Is a terrible storm on the way?

Who won the world's series game? News of these events and many others is transmitted by wireless and is an open book to the young man who can pick the messages out of the air.

Everyone knows the part played by wireless in the war. On land and sea, and in the air, wireless helped win the war. Before the war there were hundreds of Radio Amateurs operating stations of their own for pastime and instruction. Many of them joined the Radio Service and the knowledge acquired through their Amateur work enabled them to make good in the emergency.

At the present time, since the Government has removed all war restrictions on the use of wireless by Amateurs, there are thousands more who are already "listening in" on Radio news, or preparing their apparatus and getting ready for the biggest wave of popularity that Radio Telephony Telegraphy has ever experienced.

The membership of "The Experimenters Unlimited," as Radio enthusiasts call themselves, runs from boys of twelve and fourteen to men even past middle age. Grammar, High School, and College boys are represented, while men from every profession and trade find Radio Telegraphy a highly instructive, intensely interesting and useful pastime or hobby, as well as one of the most potent features in the development of our modern civilization. And you can't find one of the younger Experimenters who doesn't say he's going to follow Radio Telegraphy as a career.

There is hardly a sport or pastime more fascinating, more useful, or more practical; and which holds out greater possibilities for future development; than does Radio Telegraphy. The young man or boy who takes it up as a hobby becomes more and more interested; acquires a valuable education along more or less specialized lines; and when he follows the Science with the interest with which nine out of ten of them do, he can in a reasonably short time acquire a knowledge of the subject and an ability to send and receive messages as well as any professional.

After all, the only difference between an Amateur operator and a professional is that the professional receives pay—and good pay, too—for doing practically the same as does the Amateur on a smaller scale, for pastime, recreation and instruction.

Another form of radio communication—radio telephony—in which no knowledge of the code is necessary, progressed tremendously during 1921; progressed so far, in fact, that radio reception of music, news and reports is now nearly as popular as the playing of a phonograph. Powerful stations which broadcast all sorts of entertainment have been erected and more are in process of construction. Famous opera stars send their voices out over spaces thousands of miles in extent, to be picked up by hundreds of thousands of listeners. News, which would not otherwise be generally known until read in the morning papers, is sent out by human voice on the far flung waves of wireless every evening. Jazz bands play at these stations and dances are enjoyed in scores of homes and halls many miles away. Children going to bed in hundreds of homes located in many states have a bed-time story told them by professional story tellers. The action of beautiful operas is told in an interesting way, interspersed frequently with the songs which have previously delighted only those fortunate enough to be able to attend.

Sometimes the enterprising owner of a radio receiving set puts an extension telephone on his radio set, then, calling someone on the telephone, throws a switch and the music is heard over the land line by someone who does not believe in radio, or is not fortunate in owning a station. There is no end to the things that can be done, no greater incentive to ingenious thinking, no exhausting the possibilities offered by a simple wireless outfit.

Fathers of youthful radio experimenters find much to interest them in the Science. More than one man has remarked that he had gotten closer to his boy through their combined interest in the boy's apparatus. Mothers even, have become "Radio

Bugs" and enjoy the pastime as much as anyone else. One man wrote us saying:

"I don't know the first thing about wireless; I am just ordering these few things for my boys—I hope I have the numbers straight. If every father knew what an interest-holding, instructive and useful thing radio is for a boy or young man, there would be a mast on every roof. My boys talk Radio all day—and dream it all night, I guess. Their mother never wonders where they are or what they are up to. She knows that when they are out of school they are in the Radio Shack. They certainly get a lot of amusement and good, sound and useful knowledge out of their work. Their radio outfit is the best investment I ever made."

And for the boys themselves there is nothing that rivals radio work. This work has one great feature that is a big factor in its popularity. Radio work as practiced by the Amateur is exactly the same as radio work practiced by the professional. They both use much the same instruments, which operate on the same principles, though the Amateur's instruments are less complicated, sometimes smaller, and far less expensive. Many a would be experimenter has been discouraged in his plans for a radio station by such ideas advanced by older people, as "You will be tired of it as soon as you get it," "Why, a wireless set costs a small fortune," or "No sir, this house isn't going to have anything on it to attract lightning."

A wireless station is the one indoor occupation that never grows old or tiresome. Rainy days or winter evenings are no misfortune in the house where wireless is ticking out dots and dashes or bringing in concerts, news, stories and market reports. No, there is nothing imitation, nothing of the "play toy" about radio work. It is *real*. How real, can be understood from this somewhat brief illustration:

Imagine a big commercial Radio Station in New York City. A great accident has just happened to a steamship off

the coast and the news has just come in. The people in New York want to tell the owners of the ship, who are in Chicago, about the accident. They send the news by wireless. A professional operator transmits the message while another in Chicago receives it. But in Philadelphia there is an Amateur operator, who listens in (and he is only one of many thousands) and learns the news also. That Amateur does exactly what the Chicago operator does. He doesn't "play" or "make believe" he is doing it. He does it. That's why Radio work is so fascinating. It's real!

Some may hesitate about taking up Radio work in the belief that the Radio code is difficult. It isn't! For the average man to learn the Continental Radio Code (that used in all radio telegraphic communication) is simpler and easier than it is for a six-year old youngster to learn the alphabet. It requires study and practice, of course, but it is not difficult and can be mastered in a short time.

A knowledge of the code has saved lives on many occasions, and boys, men and women, have found it of valuable help to them to be able to send and receive messages. The alphabet and numerals of the code are given in the accompanying chart. Other information on abbreviations and special signals is given in various inexpensive books on the subject.

With the advent of the wireless telephone, which makes possible many fascinating hours with a radio set without any knowledge of a code, the value of radio commercially is increased many times over. Big corporations with branches in many cities, lumber companies with outlying camps and stations, mining companies with scattered properties, police and fire department with outlying stations, all are rapidly taking advantage of the economical means of communication offered them without the necessity of a trained operator.

No license is required for a radio receiving station, though there are certain limitations imposed by the Federal Government on amateurs who wish to send messages, and those who

do send must be licensed. Obtaining the license is a very simple matter and costs nothing.

To the boy or young man; in fact, to any man; we say—take up radio work. It is the coming Science, is moving ahead faster than any other, and is sure to develop in a more interesting and valuable way now that the secrets of the marvelous war-produced instruments are being uncovered. Take up Radio work because it offers a means of entertainment second to no other; gives useful instruction that can be made to produce tangible results later on; keeps everyone interested; enables you to get the news of all the world by wireless and provides a pastime and hobby that will get the busy man's mind into other channels.

In order that the uninformed may get a clear idea of what may seem to be a very complicated and difficult subject, we give on the following pages an explanation of the apparatus necessary to receive messages, with additional information covering the simplest, least expensive and most satisfactory way to secure, set up and operate an Amateur Radio Receiving Station whether it be to listen to radio telephony or radio telegraphy.

The Essentials of an Amateur Radio Receiving Station

MOST people have a general idea of what radio communication is: that it is a means of sending and receiving messages through the air, over short or long distances, over land or water, without connecting wires. To transmit messages by radio there must, of course, be a sending station and a receiving station. Different instruments are required for each and as it is the object of this book to cover only the receiving end of the system, the sending end will be touched on only as may be necessary in order that the principle may be made clear.

At the sending station, electric energy is generated, stored up, and released into the air in the form of electro-magnetic waves Everyone has seen the spark plug of an automobile, motor cycle or motor boat engine, and knows how the spark "jumps" across the gap at the points of the plug, thus forming the "spark" which ignites the gas. Each time the spark "jumps" the gap, electric waves are sent out. Radio sending apparatus may be said to operate on much the same principle. Electro-magnetic waves are released into the air and travel outward in ever widening circles. Scientists tell us there cannot be a *cause* and an *effect* without some connection. A sending station in Boston, for instance, sends electro-magnetic waves which are received in Buffalo. The Boston station is the *cause;* the Buffalo station the *effect.* What is the connection? There must be something on which the waves can be sent.

The atmosphere is composed of atoms of oxygen, nitrogen, helium and other known gases suspended in what the average

individual terms "nothing" or a vacuum. This "nothing," however, is known to radio engineers as the ether. To this ether can be given a wave motion similar to that which occurs in water—the wave motion travels forward while the individual particles of the medium merely move closer together and upward, then farther apart and downward.

To Transmit radio signals it is necessary, therefore, to first create waves in varying groups and of varying strength and second to intercept them with apparatus capable of changing them to sound waves.

To create the waves it is necessary to have two surfaces separated by a distance of from ten to several hundred feet and to create between them an electrical pressure which changes its direction (first toward one surface, then toward the other) hundreds of thousands of times a second. It is the common practice to use the ground for one surface and provide another surface by erecting a structure composed of one or more wires, insulated from the ground and suspended many feet above it. Between these, by means of suitable transmitting equipment we create an electrical pressure of from one to one hundred thousand volts which starts waves radiating out in all directions

These pressure waves are, however, only part of a radio wave. From any wire in which current is flowing are radiated electro-magnetic waves and radio waves are made up then, of both electro-magnetic and electro-static (pressure) waves.

The creation of these waves may be compared to the action of hurling a large rock into a pool of water. The amperes of current put into the antennae correspond to the size of the rock, while the volts of electrical pressure are equivalent to the force with which the rock is hurled. The larger the rock and the greater the force behind it, the bigger the splash and consequent waves. The more amperes of current flowing in the antennae circuit and the greater the pressure (volts) between antennae and ground, the stronger the waves radiated.

These radio waves have similar characteristics to another class of waves—sound waves. When the note C is struck on the piano, the sound waves vibrate 256 times per second, and either a C tuning fork or a wire tuned to C and in the immediate vicinity will vibrate 256 times per second also. The two wires are said to be in resonance. The waves radiated by a radio transmitter always have a definite number per second and in order to hear a station, the receiving equipment must be put in resonance with waves radiated by the transmitter.

Probably you have read or hear the term "wavelength." Sounds rather mysterious, to be talking about the length of a wave one cannot see, but the meaning is simple. Imagine that you can throw a stone from here to the moon, and that it travels a foot a second all the way, if you throw a stone every second (the first will travel one foot before the next one starts, and so on. You will then have a string of stones a foot apart traveling toward the moon. And so it is with radio waves. The waves all travel at the same invarying speed and are sent out at regular intervals. The distance from the crest of one wave to the crest of the next is the wavelength of that station's signals.

The waves thrown out by a wireless station, either large or small, travel at the enormous speed of 186,000 miles a second, or, using the metric system, 300,000,000 meters per second. As we know the speed at which all radio waves travel, and as we can always readily determine how many we are radiating per second, it is not difficult to ascertain the length of each wave, simply divide 300,000,000 by the number radiated per second. Our station, let us say, is sending out 1,000,000 waves per second; if 300,000,000 is divided by 1,000,000, the result is 300; the wavelength of our station's signals is 300 meters.

Frequencies of 15 to 15,000 are spoken of as audio frequencies, because vibrations such as these, which can be set up by a wire, can be heard, while those from 15,000 to 50,000 are called radio frequencies. They are commonly used in wireless

and are passing through the air constantly, yet they cann be heard.

Contrary to the general belief, a Radio Receiving Statio is not a complicated or difficult apparatus to set up and ope ate; or even an expensive one. While it is true that many c the commercial, Naval and Government stations, both receivin and sending, are awe-inspiring and extremely technical thing to the beginner, and that they also represent investments c many thousands of dollars; the pieces of apparatus needed b the average beginner in order to receive messages or musi are simple in detail, few in number, easy to understand an operate, and not expensive.

For receiving Radio signals, speech or music, sent by th usual stations, only six distinct things are necessary, viz:

First: One or more wires elevated from the ground and insu lated from it to form what is termed the Aerial or an tennae (pronounced An-ten-a) upon which the wireles waves are caught.

Second: A means of varying the wave lenght or responsiv frequency of the receiving station to correspond with tha of various transmitting stations. This is done with one o more tuning coils made either, flat of a single layer o wire—narrow but thick and wound in what is called "honey comb" style—or of two spherical structures of wire on of which revolves within the other and known as a vari ometer.

Third: A means of changing the frequency of the incomin signals from radio frequency to audible frequency so tha they may be heard. This is done with a Detector whic may be of either of two types—"crystal" or "vacuum tube.

Fourth: A means of making an even finer and more accurat adjustment of the circuits to the incoming waves than i

possible with the tuning coils alone. For this purpose we use a Condenser.

Fifth: A means of making the signals audible to the human ear—in other words, change them from electrical impulses to sound waves. A pair of head telephone receivers accomplish this.

Sixth: A suitable connection with the ground in order to complete the electric circuit. This is called the "Ground."

These instruments can either be purchased individually by the amateur who wishes to experiment with various types of instruments and hook-ups, or can be bought in handsome cabinets, with antennae and ground equipment, ready to be put into operation. When one has the time, equipment and inclination to do a little experimenting and make changes, the former method is preferable as a much better knowledge of the apparatus, its action and its peculiarities is gained but the latter method, the purchasing of a complete, mounted set, affords endless hours of amusement and teaches one the operation of the various controls.

Let us now take up each of the above six essentials and see briefly what each is and what it does. Of course, the most important features of your Receiving Station are the instruments you use. Without good instruments, of the highest quality, and manufactured with that care, scientific knowledge and experience which can be secured only through long practice, your station will not operate in the most efficient manner.

Radio instruments are among the most scientific of all instruments and their manufacture requires not only mechanical knowledge, but scientific knowledge and an infinite ability to handle delicate and intricate instruments.

Amateurs have in the past, made many of their own instruments, but this is no longer necessary or advisable. The advances made in the science both from an inventive and

manufacturing standpoint, make it possible for anyone to purchase at very reasonable cost, instruments of the highest type, correct scientifically, expertly designed, carefully made and much superior in appearance and practical operation to any made at home. The antennae and ground about to be described, are more or less simple parts of the whole outfit. They must be made along the lines described and to suit the individual needs of each station. When it comes to the instruments, however, there is a wide choice of selection.

THE AERIAL
(Antennae)

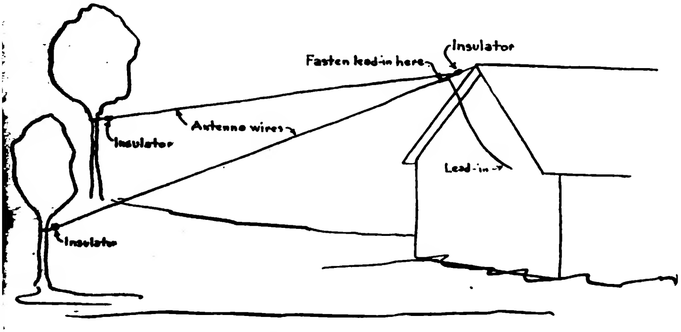
There are no fixed rules as to the shape, length heighth or number of wires of an aerial, but it *must* be well insulated. In receiving, we are working with minute currents and no one can afford to lose any that the aerial wires may pick up. There are, at present, six types of antennae in general use: The inverted L, the T, the umbrella, the Cage, the Spiral and the Loop. The first five are erected outside of buildings; the last is used indoors and occasionally outside for direction find. We

SINGLE WIRE TYPE

Figure 1.

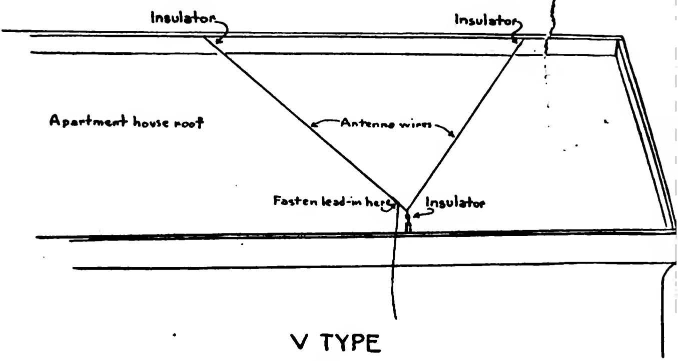
will not, here, go into a discussion of the merits and disadvantages of the various types, but will cover only the erection of the simplest and most commonly used. The loop aerial should not be considered by the beginner, as with it one must have complicated vacuum tube circuits.

The inverted L aerial may be constructed of from one to ten wires and the "lead-in" is taken off at one end. The simplest form of this type aerial is indicated by the sketch, Figure 1 and consists of a long, single wire, 60 to 110 feet long. It is presumed that the beginner wishes to listen to radiphone programs and amateur conversation and for this reason 60 to 110 feet is suggested. A longer aerial would be better suited to the reception of commercial and government stations, but would not be desirable for the 150 to 450 meters wavelength reception. This aerial should be made of hard-drawn copper wire, 12 or 14 gauge, without insulation (covering). Each end of the wire must be connected to an insulator, usually of porcelain, glass or a composition such as electrose. The long copper wire must not, itself, be connected to the house, tree or pole. Each end must be fastened to an insulator and this insulator fastened



V TYPE

Figure 2.



V TYPE

Figure 3.

to the building, tree or post, supporting the aerial, by a 4 to 10 inch piece of wire.

Then comes the "lead-in"—the wire connecting the antennae to the instruments. This should, if possible, be soldered to the aerial wire proper. If more than one wire is used in the antennae, a 6 foot length of antennae wire should be soldered to each of the long wires and these short lengths brought together and soldered to a single "lead-in" wire. This "lead-in" should be brought down from the aerial in the most direct and if a corner must be rounded, should be fastened to an insulator that will keep it clear of roof edge, chimney or other object.

Figures 2 and 3 show modified forms of inverted L antennae usually referred to as "V" antennae. The wires do run parallel as in a true, multiple wire inverted L, but each wire, considered with the vertical "lead-in," forms an inverted L.

The T antennae is used where a stretch of 140 to 230 feet is either available or necessary and it is desired to have the station and instruments in the center of this span. One or more wires are used but the lead-in is taken from the center of the wire or wires. If a single wire is erected, the same effect is obtained as from two wires half the length of the long span.

The umbrella type aerial is employed where a stretch of nore than 40 feet is not available and consists of from six to en wires connected to, but insulated from, the top of a 30-40 oot pole. They radiate outward and downward from the top of the pole and are insulated at their lower ends which should e about 20 feet from the base of the pole. All are connected ogether at the top and a common "lead-in" brought down.

The cage and spiral types are rather complicated of contruction and it is advisable to defer their erection until more ully acquainted with radio and the advantage of various aerials. Figure 4 shows the usual method of bringing the lead-in into the operating room. A board is fitted under the window so that when the window is closed down on the edge of the board, no air comes in. Bore a hole in the board, put an insulator through the hole and draw the lead-in wire through the insulator. You must now have a "Ground." Locate a cold-water pipe near your operating room. A gas or

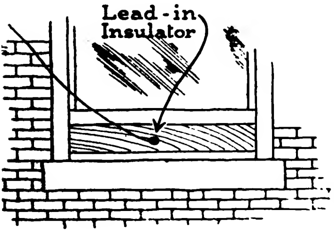


Figure 4.

team pipe will not do as frequently a non-conducting length is nserted in the former before it reaches the earth and often the atter never reaches the earth. Scrape or sandpaper a 6 inch pace all around your water pipe until it is bright; then wind round this space ten or twelve turns of Annunciator or other nsulated No. 14 to No. 20 wire from which the insulation has een removed. If possible, solder it fast, but if this cannot e done, wind insulating tape around pipe and wire to keep out noisture, which would corrode wire and pipe. Now run the nsulated wire back to the instruments, which completes what s known as the antennae-ground circuit.

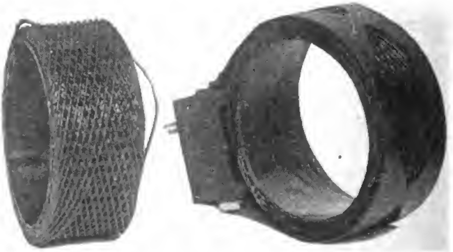


Figure 5.

THE TUNING COIL

Tuning coils, which are used in several ways in receivin circuits have been designed and brought out in many differen shapes and sizes. The purpose of tuning coils is to secure an adjustment of the receiving apparatus such that the circuits ar responsive to, and will receive signals from any station desired Of all the types brought out, but two have survived actual us and are now found in the vast majority of stations: The singl layer of wire wound on a tube and the "honeycomb." The firs is varied either by tapping it every few turns and bringing th tap wires to points on a switch or by scraping the insulatio from the wires for a width of ¼ inch the length of the coil an causing a movable contact to slide along this bare strip. Indi vidual "honeycomb" coils, which take their name from th method of winding them, are not variable; different size coil being used for various ranges of wave lengths, *i. e.,* one coi for wave lengths 145-150, another for wave lengths 150-225, etc These coils have contact pins in the bakelite block attached, an are "plugged in" into receptacles mounted on a panel. Figur 5 illustrates the De Forest honeycomb Duo-Lateral wound tuning coil, embodying features of winding exclusive with D Forest coils and enabling them to replace other more cumber

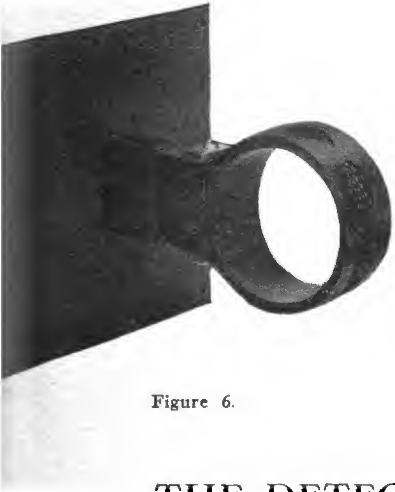


Figure 6.

some, less effective and more troublesome types heretofore used by amateurs. Figure 6 shows a "honeycomb" plugged into the mounting on a panel. In what are termed "single-circuit" sets, the best for the novice in the radio field, the single layer coil, varied by a sliding contact, is generally used. In sets which have two or more tuning circuits, the honeycombs are always preferable.

THE DETECTOR

The next piece of apparatus essential is the detector. There ave, in the evolution of radio, been many types of detectors, ach having a short period of popularity, only to be replaced n desirability, by another more sensitive. Coheror, carborundum, electrolytic, pyrites and silicon—each had its day, n about the order named, and was discarded. We now find two n general use; that employing a piece of galena (lead peroxde) and that using a vacuum tube. The action of a detector nay be briefly stated as changing the high frequency (20,000 o 6,000,000 changes of direction per second) radio currents to mpulses of varying strength traveling in one direction only.

Galena crystals possess this property and for that reason we nd them, in radio work, mounted in a small block of soft netal with one surface exposed. A short spring made of fine

phosphor bronze wire is mounted directly in front of this su
face and so attached to the base of the instrument that one e
can be made to tou
any point of the e
posed surface of t
galena crystal. (S
Figure 7.) This
necessary as
points on the surfa
of a piece of gale
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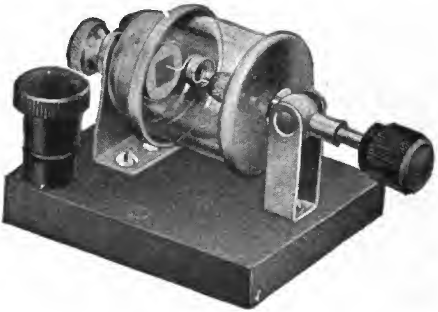


Figure 7.

"sensitive" points. Once such a point is found, and the d
tector is not jarred, re-adjustment will not have to be ma
for some time.

The audion or vacuum tube first brought out by I
Lee De Forest, is the most interesting instrument whi
has been developed during the progress of the radio a
It is one of the most sensitive instruments known
science, yet it does not require more than an elementa
knowledge to use it in radio reception. The vacuum tube co
sists of a glass bulb, similar in shape to an electric lamp, evac
ated to a high degree and containing three elements: the fi
ment, the plate and the grid. The filament is a piece of hi
resistance wire which is heated, by current, to brilliancy, as
an electric light. When this filament is heated it throws
millions of little electrically charged units known as negat
ions. Around the filament is constructed a small sheet of me
(the plate) to which the ions can go, and so return to the c

iit. Ions can travel only from the hot filament to the comiratively cold plate and cannot reverse and go the other way. is this property which is utilized when employing the vacuum ibe as a detector for changing the radio waves into direct cur:nt impulses. It is necessary to have some means of controlling ie number of ions which reach the plate and for this the "grid" is inserted. (See Figure 8.) The grid consists of a closely wound spiral or finely woven screen of wire surrounding the filament and through which the ions must pass to reach the plate. Interposed in the path from filament to plate, any electrical charges put upon it from the antennae circuit will either increase or decrease the ions reaching the plate and the current through the head receivers.

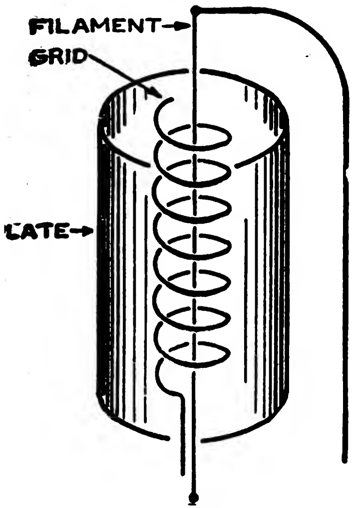


Figure 8.

The vacuum tube detector gives louder, clearer signals in the receivers than does the galena cryal detector because a small battery made up of flashlight cells id known as a "B" battery is connected in what is called the)late circuit" and a very small current is constantly taken from iis battery and added to the signal currents. Thus the signals ·om this type are much stronger and cause greater vibration f the diaphragms in the head telephones.

THE CONDENSER

We will now take up the Condenser. Condensers for use i receiving sets are of two types—Fixed and Variable. The have what is termed "capacity," *i e.,* just as a jar has a certai capacity for containing water, so a condenser will contain definite amount of electricity. As the name implies, the capacit of a Fixed condenser is definite and unchangeable but the ca pacity of a variable condenser may be changed as well.

Figure 9 shows, diagrammatically, the construction of fixed condenser although mica is now used instead of paper an sheet copper is preferable to tinfoil. As will be noted, fiv sheets of tin foil are shown, all separated from each other b the paper. Sheets one, three and five all project beyond th paper at the right and are connected together. Sheets two an four project at the left and are connected together. The pil is then clamped tightly together and is ready for use.

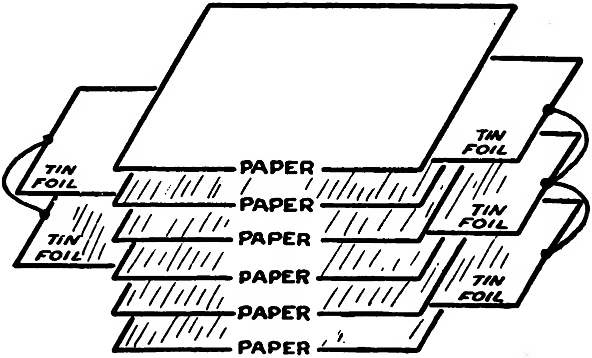


Figure 9.

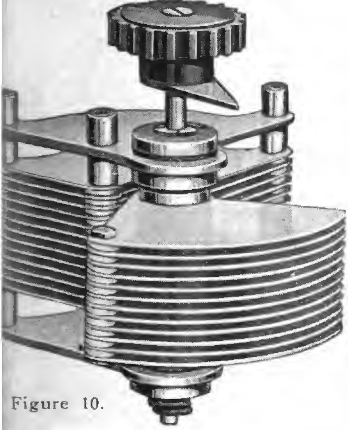


Figure 10.

In Figure 10, we have an illustration of a variable condenser. Semi-circular plates of aluminum are mounted on three pillars and separated about 1/8 inch by small washers. Another battery of semi-circular plates, slightly smaller in size are mounted on a shaft and also separated 1/8 inch.

The two groups of plates are then fastened in such relation to each other that the plates of the second group can be swung between the plates of the first group but not touching them. The knob and pointer shown are connected to the shaft of group two and turning the knob to the right swings this group in between the plates of the first group, so varying the capacity. The Honeycomb Tuning Coil described before, enables an operator to vary his circuit so that it is responsive to incoming signals but this "tuning" is not sufficiently accurate or "fine," so a Variable Condenser is used to secure a more precise degree of accuracy and to enable the operator to hear even very weak signals When the single layer, movable contact type of tuning coil is used, a Fixed Condenser is employed in the circuit.

THE HEAD TELEPHONES

The purpose of the head telephone receivers as shown in Figure 11 is to change the varing direct current impulses of

Figure 11.

the receiving circuit to soun waves. There must then, be tw distinct parts in a receiver; on that will be affected by the im pulses and affect the other pat that will, in turn, affect the ai and cause it to vibrate at audibl frequencies. If a piece of sof iron is surrounded by a coil o wire, and current is çaused t flow in the wire, the iron wi become more or less magnetic a larger or smaller current is ap plied. In a head receiver ther we find two pieces of soft iror each surrounded by a coil of fin wire, the coils being connecte to each other and the receiving circuit. As the impulses cause by the incoming signals vary, being stronger or weaker, th magnetic strength of the iron cores varies proportionatel Mounted very close to, but not touching, the ends of these core is a round, thin, springy disc or metal containing iron, th center of which is attracted to the cores to a greater or lesse degree as the impulses vary. This springy disc, called the dia phragm, acts on the air in contact with it and as it bend toward and away from the magnets within the receiver, create vibrations of the atmosphere at a frequency per second tha is audible.

THE AMPLIFIER

We will now take up a piece of equipment that is not es sential to the successful operation of a radio receiving set, bu is very desirable and permits more than one or two people t

isten to concerts and radio telegraphic signals. This is known s the audion amplifier. The word amplify means to increase, o add to, to exaggerate and that is exactly what this piece of pparatus does to the radio signals after they have been tuned n and have gone through the detector—it increases and adds to he strength of the signals.

It was stated in the foregoing paragraph that the amplifier permits more than one or two people to "listen in." That s one of its advantages. The other is that it makes faint signals audible that you would never hear at all or, if you could, vould be unable to understand. For example, a receiving set s installed in Albany, New York, the detector is adjusted perectly and the operator is tuning the set. The afternoon concert sent out from a broadcasting radio telephone station in New York City is heard clearly but the operator has learned hat an important football game will be detailed play-by-play y a station in Pittsburgh. Tuning carefully and straining his ars for weak signals, the operator suddenly pauses in his urning of the knobs. Scarcely audible in the head receivers nd so faint that one can catch only a word here and there, is he voice of the Pittsburgh operator. " . . . goes through ackle . . . yards. . . . punts and . . . brings the all . . . twenty . . . It . . . down and . . ." n vain the Albany operator adjusts the detector, carefully turns is tuning coil controls, tightens his connections. It is tantazing. If the signals were only 15% clearer he could follow hat game.

On the other side of town is another station. The tuning pparatus and the detector are identical with those of the first tation. Yet seated around the room, without receivers on their eads, are twelve people listening to a voice: "Gilman goes hrough tackle for seven yards. Penn State punts and Gilroy rings the ball back twenty yards. It is first down and Navy as the ball on its 35 yard line."

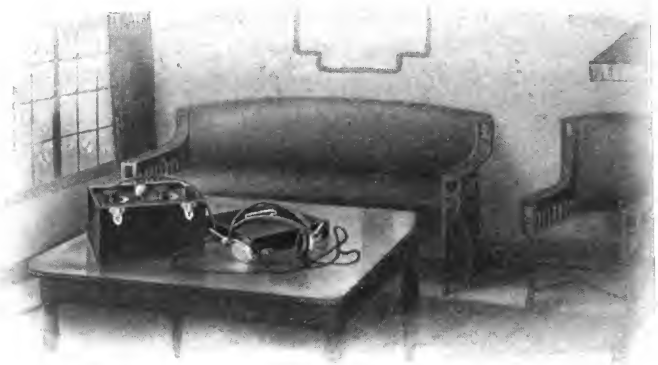
Beside the tuner and detector of this set is a compact, a tractive cabinet with but two controlling knobs projecting fro the panel; above the set is a large horn from which comes tl voice. The cabinet contains the amplifier, the horn is term the "loud speaker." But the horn is useless without the amp fier which is adding to and increasing the signals to abo 10,000 times the strength at which they are heard so faint at the other station.

It was stated in the last paragraph of our discussion the vacuum tube detector that a "B" battery made up of flas light cells was connected in the circuits and that current fro this battery was added to the signals. When the vacuum tul is used as a detector, this action of adding to the signals very small. Due to its having other characteristics than tho utilized in detecting, the vacuum tube is also used to strong amplify or increase the signals. A tube, when properly co nected in the circuits, will not change the form of signals pas ing through it as it did when detecting but will add lar amounts of current to them and so increase the audibility abo 10,000 times. A single tube, with its controls, thus used known as a "one step amplifier" or as one stage of amplific tion. If another is added, the two are called a "two step ai plifier" or as two stages of amplification.

Let us take any of the two step amplifiers now on t market and see what is in it. The two wires which are co nected from the ordinary receiving circuit to the amplifier r directly to what is known as an amplifying transformer. its name suggests, it transforms; the energy being put into is changed but not increased. This energy is made up of t factors, voltage (pressure) and amperage (current) and transformer increases the voltage to six times its origi strength and cuts the amperage to one-sixth of its origi strength. We will not here go into the technicalities of this is desirable but take it for granted that radio engin have found it necessary. From the transformer, two wires

the first vacuum tube, one to the grid and one to the filament. is filament is lighted, as was the detector tube, by a storage tery. Like the detector tube, this amplifier tube has a plate, l we find a wire from it connected to another amplifying nsformer. The other of the two input wires of this second nsformer and a wire from the filament of the tube just ntioned lead to binding posts, to which you connect two B teries made up of flashlight cells and giving 45 volts. It is m these B batteries that the amplifier takes energy and adds o the signals. The output wires of the second transformer connected to another tube, and, as in the case of the first e, the plate and filament of tube two are connected to the B batteries. Thus both tubes amplify or increase the sig- s many thousand times.

The deForest Everyman Radiophone Receiver



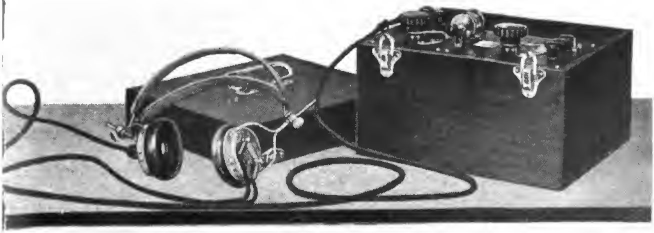
THIS set is designed for use by those who live within radius of forty miles of one of the existing broadcasti stations. While brought out primarily for use in rece ing radio telephone concerts, news and reports, it also brin in radio telegraphic signals from stations up to 300 miles d tant, depending, of course, upon the power of the transmitti stations, *i. e.,* 100 K. W. stations, 300 miles; 25 K. W. statio 100 miles; 1 K. W. stations, 30 miles. These figures are gi for average local conditions which vary with every station, a they are not guaranteed.

The instruments are cased in a handsome walnut-finis cabinet with carrying handle, which contains space for "d lateral" coils, head telephone receivers and pad and penc

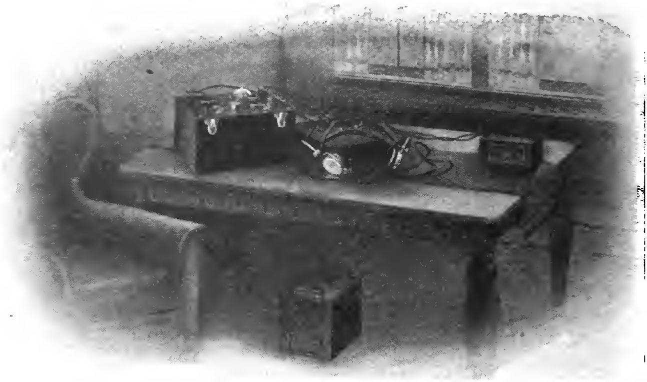
binet is 10 inches long, 8 inches wide, and 7 inches high. The ight complete is five pounds. Only reliable, high grade head eivers made by well-known manufacturers are supplied with Everyman. The various parts included in the set, such as obs, binding posts, condenser and detector are identical with se included in higher priced De Forest equipment and every is tested before it leaves the factory.

The Everyman Radiophone Receiver is of the single circuit e, simple and easily adjusted, with a wave length range of to 700 meters. This range includes amateur, special ama-r, broadcasting and ship stations. By the plugging in of io-lateral" coils the wave length range may be increased to lude many of the high power stations in this country. There only one type of radio transmission which this set will not ng in—continuous wave. However, practically the only sta-ns using this form of transmission are the transatlantic ions.

Due to its compactness and light weight, this set is ideal use by hiking parties, boy scouts, campers, etc. It is not y, but an efficient, dependable, well-made radio receiver, and rried by electrical dealers, jewelers, hardware stores, sport-goods and department stores. The Everyman requires no eries and its price ready for operation is $25. Antennae pment which includes antennae wire, insulators, lightning ster, ground wire and ground clamp is $7.



The deForest Radiohome Receiver



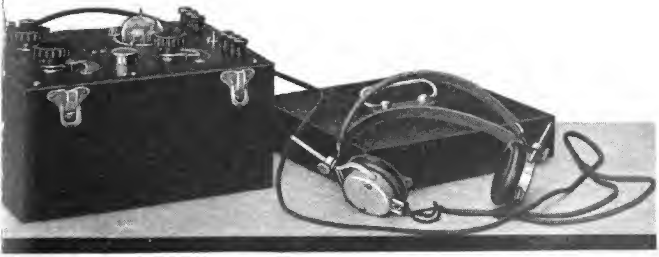
A big brother of the Everyman Receiver, identical in
and outward appearance but equipped with a vacuum tube
tector which increases the sensitivity and, consequently,
receiving range. It is intended for use in the reception
broadcast radio telephone programs but also brings in sig
from stations using "spark" and modulated continuous w
transmitters. Under normal conditions it will bring in
nals from 100 K. W. stations 700 miles distant, 25 K. W. stat
250 miles away and 2 K. W. broadcast stations that are
miles away.

The circuit used in this set is not of the regenerative t
the leading radio engineers being agreed that the complexity
controls necessary and the difficulty of operation with suc

rcuit, are not worth the slight benefits obtained from regener-tion which is valueless in the reception of radio telephone gnals and seriously distorts them.

The circuit for tuning is the same, simple, single-circuit iat has made the Everyman so popular and the wave length inge is 145 to 700 meters. There is only one additional con-ol and that is the filament rheostat. However, once set it ill require but occasional change. Should you care to in-ease the wave length range of the Radiohome, you have but purchase two or three honeycomb, duo-lateral wound coils id the set will bring in signals sent on wave lengths from 00 to 12,000 or 15,000 meters.

Additional equipment necessary with this set is one de-ctor vacuum tube, one 22½ volt "B" battery, one pair of head lephone receivers and an "A" battery. This last item may nsist of three or four dry cells such as are used for ignition bell-ringing but a storage battery of 4 or 6 volts is prefer-le. The capacity of the storage battery may be 20, 40, 60 80 ampere hours. The same antennae equipment listed on ge 29 may be used or an antennae of 4 wires from 60 to 0 feet long can be erected. Price of the Radiohome, with-t tube, batteries or receivers, $36. Price, complete with tube, rage battery, "B" battery, head receivers and antennae equip-nt, $72.



THE DE FOREST TWO-STEP AMPLIFIER

Type SP-2.

Two of the most recent developments of radio design h been embodied in this instrument: binding posts on the rear cabinet which is vertical and jacks which open and close b plate and filament circuits. The first of these features ke unsightly wires from detracting from the appearance of instrument. The second saves re-adjustment of the rheos every time the set is used and saves both A and B batter A handsome, beautifully constructed instrument of which owner may be proud.

Price, without tubes or batteries........................$4

Special